

**REMARKS**

Claims 14, 18, 21 and 28-34 are pending. By this Amendment, Claims 21 and 30 are amended, and new Claims 31-35 are added. Reconsideration of the June 13, 2003, Official Action is respectfully requested.

Claims 21 and 30 stand rejected under 35 U.S.C. § 102(b) over U.S. Patent No. 5,384,009 to Mak et al. ("Mak"). The reasons for the rejection are stated at numbered paragraph 2 of the Official Action. The rejection is respectfully traversed.

Claim 21, as amended, recites "an oxygen-free plasma etching gas formulation for removing an organic ARC on a metallic layer comprising (i) *more than one fluorine-containing compound*, (ii) *an inert carrier gas selected from the group consisting of krypton, argon, neon, helium, and mixtures thereof*, and (iii) chlorine, the gas formulation being free of SF<sub>6</sub>" (emphasis added). Support for the amendments to Claim 21 is provided at page 6, lines 3-5, of the specification. According to Claim 21, the etching gas formulation comprises the inert carrier gas; i.e., the carrier gas is *not* optional. Mak fails to disclose or suggest the etching gas formulation recited in Claim 21.

The Official Action asserts that Mak discloses a process gas lacking oxygen, and comprising (i) a primary etchant selected from the group consisting of chlorine, fluorine, and bromine; (ii) a secondary etchant suitable for etching grain boundaries in the substrate; and (iii) *xenon*. It is further asserted that the process gas can have a gas passivator, such as N<sub>2</sub>, HCl, CHF<sub>3</sub>, CF<sub>4</sub>, CH<sub>4</sub>, or mixtures thereof. The Official Action also asserts that Mak

discloses that the secondary etchant preferably is selected from "the group consisting of  $\text{BCl}_3$  ... and mixtures thereof."

Mak discloses a process for selectively etching a substrate having grain boundaries, and a resist material on the substrate. Mak discloses a process gas that comprises xenon, but fails to disclose or suggest that xenon could be replaced by another noble gas in the process gas. Thus, Mak fails to disclose or suggest the combination of features recited in Claim 21, which is thus patentable over Mak.

Claim 30 depends from Claim 21 and thus also is patentable over Mak for at least the same reasons that Claim 21 is patentable.

Withdrawal of the rejection is therefore respectfully requested.

Claims 14, 28, and 29 stand rejected under 35 U.S.C. § 103(a) over Mak. The reasons for the rejection are stated at numbered paragraph 8 of the Official Action. The rejection is respectfully traversed.

Claim 14 recites "an oxygen-free plasma etching gas formulation for removing an organic ARC on a metallic layer comprising  $\text{CHF}_3$ , *argon* and  $\text{HCl}$  or  $\text{BCl}_3$ , the gas formulation being free of  $\text{SF}_6$ " (emphasis added). Mak also fails to suggest the etching gas formulation recited in Claim 14 for the following reasons.

Mak fails to disclose or suggest that the process gas comprises an inert carrier gas selected from the group consisting of krypton, argon, neon, helium, and mixtures thereof, as recited in Claim 14. Moreover, Mak discloses that the process gas preferably has a low ionization potential (col. 2, lines 10-12). Xenon has a lower ionization potential or

"ionization energy" ( i.e., the amount of energy required to remove one electron from an atom to form a cation) than each of krypton, argon, neon, and helium, as recited in Claim 21. The attached L. Pauling, *General Chemistry*, page 118 (1988), shows that xenon has an ionization energy of 12.1 eV; krypton of 14.0 eV; argon of 15.8 eV; neon of 21.6 eV; and helium of 24.6 eV. Applicants submit that Mak teaches away from the use of the recited inert carrier gases because they have a higher ionization potential (and a lower atomic weight) than xenon. Mak does not suggest that *any* noble gas other than xenon might provide the same advantages that Mak discloses xenon provides if such noble gas was to be added to the process gas. Thus, the etching gas formulation recited in Claim 14 also is patentable over Mak.

Claims 28 and 29 depend from Claim 14 and thus are also patentable over Mak for at least the same reasons that Claim 14 is patentable.

Withdrawal of the rejection is therefore respectfully requested.

Claim 18 stands rejected under 35 U.S.C. § 103(a) over Mak in view of U.S. Patent No. 4,208,241 to Harshbarger et al. ("Harshbarger"). The reasons for the rejection are stated at numbered paragraph 9 of the Official Action. The rejection is respectfully traversed.

Claim 18 recites "an oxygen-free plasma etching gas formulation for removing an organic ARC on a metallic layer comprising CHF<sub>3</sub>, argon and chlorine, the gas formulation being free of SF<sub>6</sub>, and a ratio of flow rates of CHF<sub>3</sub>:argon:chlorine in the formulation is 5

to 80 sccm:5 to 80 sccm:5 to 60 sccm." Mak and Harshbargar fail to disclose or suggest the combination of features recited in Claim 18 for the following reasons.

Mak discloses that the process gas comprises xenon, but fails to disclose or suggest that any other noble gas could be used in the etch gas. The Official Action asserts that xenon and argon are "equivalent: they belong to [the] same chemical family and possess the *same chemical properties*" (emphasis added). However, this assertion is incorrect. Xenon and argon are *not* equivalent at least with respect to their ionization potentials and atomic weights. Mak discloses that an etch gas with a low ionization potential provides for selective etching of a substrate having a resist material on the substrate. Mak fails to disclose or suggest using a noble gas having an ionization potential higher than (or a molecular weight lower than) that of xenon in the process gas.

The Official Action further acknowledges that Mak fails to disclose the ratio of flow rates of  $\text{CHF}_3$ :argon:chlorine, as recited in Claim 18. However, it is asserted that Harshbarger discloses an etch gas composition encompassing the flow rate ratio of the etch gas composition as recited in Claim 18, and that it would have been obvious to modify Mak's process using Harshbarger's method of varying the flow rate of an etching gas. Applicants respectfully disagree with these assertions.

The claimed etchant gas composition is effective to remove an organic ARC on a metallic layer. In contrast, Mak's process uses (1) a volumetric flow ratio of primary etchant:secondary etchant:xenon that achieves a substrate to resist etching selectivity ratio greater than 2.5, (2) a volumetric flow ratio of secondary etchant to primary etchant to

achieve a rate of etching of the substrate grain boundaries that is substantially the same as the rate of etching of the substrate grains, (3) a certain volumetric flow ratio of xenon to primary etchant to achieve particular objects, and (4) a certain volumetric flow ratio of passivator to primary etchant to avoid the problems of undercutting and slow etch rates (col. 4, lines 20-51).

Harshbarger discloses an etchant gas composition at column 4, line 59 - column 6, line 29. However, the disclosed gas composition does not comprise  $\text{CHF}_3$ , argon, and chlorine, as recited in Claim 18. Moreover, Harshbarger fails to provide ratios of flow rates of *individual components* of the etch gas composition. Accordingly, Harshbarger fails to disclose or suggest the ratio of flow rates of  $\text{CHF}_3$ :argon:chlorine, as recited in Claim 18. Clearly, Harshbarger provides no motivation to modify Mak's process gas to achieve a ratio of flow rates of  $\text{CHF}_3$ :argon:chlorine, as recited in Claim 18.

The Official Action asserts that it would have been obvious to modify Mak by using Harshbarger's method of varying the flow rate of an etchant gas "since it has been held that discovering an optimum value of a result effect variable involves only routine skill in the art." However, this assertion presupposes without any supporting evidence or rationale that the optimization of variables in accordance with the disclosures of Mak and Harshbarger would yield an etching gas formulation having the ratio of flow rates of  $\text{CHF}_3$ :argon:chlorine recited in Claim 18. That is, the Official Action has not established that the resulting gas composition, even if *optimized to provide the needs of Mak*, might have the claimed ratio of flow rates of  $\text{CHF}_3$ :argon:chlorine. Accordingly, the rejection is

based entirely upon speculation and not upon a factual basis, and therefore is improper.

*See, for example, In re Warner*, 154 USPQ 173, 178 (CCPA 1967). Accordingly, Claim 18 also is patentable over Mak and Harshbarger.

Withdrawal of the rejection is therefore respectfully requested.

New Claims 31-33 depend from Claim 21, and recite that the gas formulation comprises argon, neon, and helium, respectively. As explained above, Mak fails to disclose or suggest substituting any one of these noble gases for xenon in the process gas. Accordingly, Claims 31-33 also are patentable for at least the same reasons that Claim 21 is patentable.

New Claim 34 depends from Claim 14 and recites that the gas formulation *consists essentially* of CHF<sub>3</sub>, argon, and HCl or BCl<sub>3</sub>. According to MPEP § 211.03, pages 2100-50 - 2100-51 (Feb. 2003), "[t]he transitional phrase 'consisting essentially of' limits the scope of the claim to the specified materials ... 'and those that do not materially affect the basic and novel characteristic(s)' of the claimed invention."

As explained, Mak does not disclose or suggest including argon in the process gas, as recited in Claim 34. In addition, Mak discloses that the process gas *requires* a primary etchant selected from the group consisting of chlorine, fluorine, and bromine. Clearly, Mak fails to disclose or suggest the gas composition recited in Claim 34. Accordingly, Claim 34 also is patentable for at least the same reasons that Claim 14 is patentable.

New Claim 35 depends from Claim 18 and recites that the gas formulation *consists essentially* of CHF<sub>3</sub>, argon, and chlorine. Mak fails to disclose or suggest including argon

in the process gas. In addition, Mak discloses that the process gas *requires* a secondary etchant preferably selected from the group consisting of  $\text{BCl}_3$ ,  $\text{SiCl}_4$ ,  $\text{CCl}_4$ , and mixtures thereof (col. 3, line 67 - col. 4, line 1). The secondary etchant is provided to etch grain boundaries in the substrate. Clearly, Mak fails to disclose or suggest the gas composition recited in Claim 34. Accordingly, Claim 35 also is patentable for at least the same reasons that Claim 18 is patentable.

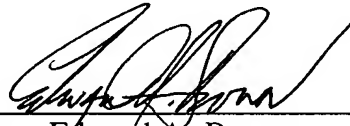
For the foregoing reasons, it is submitted that the application is in condition for allowance and such action is earnestly solicited.

Respectfully submitted,

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Date: July 30, 2003

By: \_\_\_\_\_

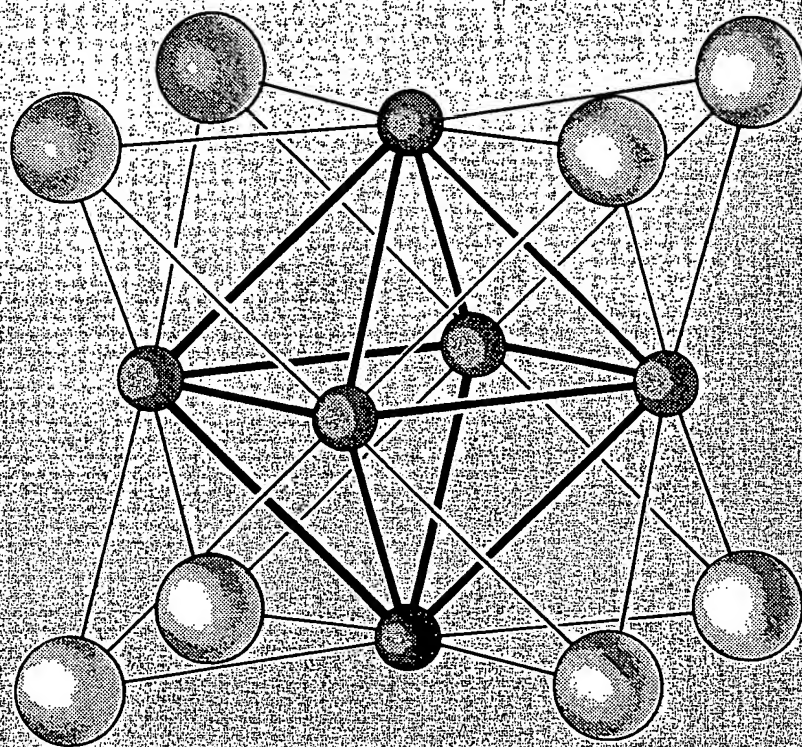


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# GENERAL CHEMISTRY



Linus Pauling

# Preface

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In the first edition of this book, published 22 years ago, I attempted to  
simplify the teaching of general chemistry by the correlation of the facts  
of descriptive chemistry, the observed properties of substances, to as  
great an extent as possible with theoretical principles, especially the  
theory of atomic and molecular structure. This correlation with theory  
was extended in the second edition, and is extended still further in the  
present edition.

The theories of greatest value in modern chemistry are the theories of  
atomic and molecular structure, quantum mechanics, statistical mechanics,  
and thermodynamics. In this book I have tried to present in a sound and  
logical way the development of these theories, in their relation to chem-  
istry. The principles of quantum mechanics are discussed on the basis of  
the de Broglie wavelength of the electron. The quantized energy levels of  
a particle in a box are derived by means of a simple assumption about the  
relation of the de Broglie waves to the walls of the box. No attempt is  
made to solve the Schrödinger wave equation for other systems, but the  
wave functions of hydrogen-like electrons are presented and discussed in  
some detail, and the quantum states for other systems are also discussed.

I have found that an understanding of statistical mechanics (especially  
in its quantum-mechanical form) is more easily obtained by the beginning  
student than an understanding of chemical thermodynamics. It is for this  
reason that I have introduced statistical mechanics before thermo-  
dynamics, and have based the discussion of thermodynamics on it.

[v]

TABLE 5-1

First and Second Ionization Energies of the Elements (in eV)

Z	$I_1$	$I_2$	Z	$I_1$	$I_2$
1	H	13.60	24	Cr	6.76
2	He	24.58	25	Mn	7.43
3	Li	5.390	26	Fe	7.87
4	Be	9.32	27	Co	7.86
5	B	8.30	28	Ni	7.63
6	C	11.26	29	Cu	7.72
7	N	14.53	30	Zn	9.39
8	O	13.61	31	Ga	6.00
9	F	17.42	32	Ge	7.88
10	Ne	21.56	33	As	9.81
11	Na	5.138	34	Se	9.75
12	Mg	7.64	35	Br	11.84
13	Al	5.98	36	Kr	14.00
14	Si	8.15	37	Rb	4.176
15	P	10.48	38	Sr	5.69
16	S	10.36	39	Y	6.38
17	Cl	13.01	40	Zr	6.84
18	Ar	15.76	41	Nb	6.88
19	K	4.339	42	Mo	7.10
20	Ca	6.11	43	Tc	7.28
21	Sc	6.54	44	Ru	7.36
22	Ti	6.82	45	Rh	7.46
23	V	6.74	46	Pd	8.33

A simple interpretation of these values is based on the idea that each electron is shielded somewhat from the nucleus by the other electrons in the atom. Let us represent the effective nuclear charge of an atom (for a particular electron) by  $(Z - S)_e$ , in which  $S$  is the *shielding constant* (also called the *screening constant*). The ionization energy for an electron with total quantum number  $N$  is then given (from Equation 5-5) by the equation

$$I = \frac{(Z - S)^2}{n^2} \times 13.60 \text{ eV} \quad (5-11)$$

**Example 5-2.** What is the shielding constant of one of the two electrons in the helium atom for the other? Assume that both electrons have  $n = 1$ .

**Solution.** The value of  $I_2$ , 54.40 eV, is just  $2^2 \times 13.60$  eV, as given by Equation 5-11, with  $n = 1$ ,  $Z = 2$  (for helium), and  $S = 0$ , as expected. We equate  $I_1$ , 24.58 eV (Table 5-1), to  $(2 - S)^2 \times 13.60$  eV, and obtain  $S = 0.66$ .

Z	$I_1$	$I_2$	Z	$I_1$	$I_2$
47	Ag	7.57	70	Yb	6.2
48	Cd	8.99	71	Lu	5.0
49	In	5.79	72	Hf	5.5
50	Sn	7.34	73	Ta	7.88
51	Sb	8.64	74	W	7.98
52	Te	9.01	75	Re	7.87
53	I	10.45	76	Os	8.7
54	Xe	12.13	77	Ir	9
55	Cs	3.893	78	Pt	9.0
56	Ba	5.21	79	Au	9.22
57	La	5.61	80	Hg	10.43
58	Ce	6.6	81	Tl	6.11
59	Pr	5.8	82	Pb	7.42
60	Nd	6.3	83	Bi	8
61	Pm		84	Po	8.43
62	Sm	6	85	At	
63	Eu	5.66	86	Rn	10.75
64	Gd	6.2	87	Fr	
65	Tb	6.7	88	Ra	5.28
66	Dy	6.8	89	Ac	6.9
67	Ho		90	Th	12.1
68	Er		91	Pa	
69	Tm		92	U	5

**Example 5-3.** Assuming  $\text{Li}^+$  and  $\text{Al}^{3+}$  to contain two electrons with  $n = 1$ , evaluate the shielding constant from the observed values  $I_2 = 75.0$  eV for Li (Table 5-1) and  $I_2 = 2085$  eV for Al (given above).

**Solution.** Use of Equation 5-11 as in Example 5-2 leads to  $S = 0.64$  for  $\text{Li}^+$  and  $S = 0.62$  for  $\text{Al}^{3+}$ . We conclude that the screening effect of one electron with  $n = 1$  for another with  $n = 1$  is nearly independent of  $Z$ .

**Example 5-4.** We assume from the trend of values of  $I_1$  and  $I_2$  in Table 5-1 that the lithium atom contains two inner electrons with  $n = 1$  and one outer electron with  $n = 2$ . If the inner electrons shielded the outer electron completely from the nucleus the value of  $I_1$  would be  $(3 - 2)^2/2^2 \times 13.60 = \frac{1}{4} \times 13.60 = 3.40$  eV. If they had no shielding effect, the value of  $I_2$  would be  $3^2/2^2 \times 13.60 = 30.60$  eV. The observed value (Table 5-1) is 5.390 eV. How effective are the two inner electrons in their shielding action for the outer electron?